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(54) Apparatus for processing and reproducing image information

Gerät zur Bildinformationsverarbeitung und -wiedergabe

Appareil pour le traîtement et la reproduction d'information d'images

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Description

[0001] The invention relates to apparatus for reproducing an image, comprising

- means for supplying digital image dot information representing said image,
- a memory for storing image dot information, and
- means for processing the supplied image dot information.

The term "image dot information" in this context denotes the density values of pixels (image dots) disposed in an orthogonal raster and together corresponding to the image.

[0002] Apparatus for processing supplied digital image dot information are generally known. In these known apparatus, a document is scanned by means of an optoelectrical scanner and digital image dot data are generated which correspond to the document image. These image dot data are stored in a memory, processed and printed. Digital image dot data can also be supplied from another device, stored in the memory, and be printed after processing. The processing is generally aimed at so adapting the image data that a good print is obtained, e.g. converting grey value data into halftone data, i.e. image data which can only have the value black or white for each image dot.

[0003] In addition, processing may be aimed at changing the appearance of the printed image of the document according to an operator's choice. This is usually referred to as editing. In that case, selection means, such as a digitising panel and an indicator pen, can be used to indicate an area of the document, whereafter a processing function instruction can be given to change the appearance of the indicated area.

[0004] Such a system is disclosed in GB-A-2 515 106. Areas on the original document which need a specific image processing method (in the example given: "thresholding" or "dithering") are defined, by an operator, using an "original-setting device" having scales at the sides. The operator notes the coordinates of the upper, lower, left and right borders of the image area that has to be processed (areas are rectangular) and enters these coordinates in a processing section, together with the required processing method.

[0005] A disadvantage of the conventional devices is that the areas to be processed must be indicated very accurately. If an area to be processed is indicated carelessly, a part which should really also have been processed may easily be omitted.

[0006] It would therefore be advantageous to base the selection of an area the visual appearance of which is to be changed on an analysis of the lay-out of the document image.

[0007] To this end, an apparatus can additionally be provided with

- segmentation means, connected to the memory, for automatically making a layout analysis of the image and correspondingly segmenting the digital image dot information into layout elements,
- operating means, connected to the segmentation means for receiving therefrom results of the segmentation and being provided with:
  - means for displaying said results to an operator,
  - first selection means for selecting one or more layout elements found during the segmentation.

[0008] The segmentation means analyse the layout of the document, and the determined layout of the document is shown to the operator, e.g. on a display, whereupon he can select layout elements just as is done on the display of a word processor station.

[0009] Layout analysis is well known in the art, as will be discussed hereinafter. It is used in combination with optical character recognition (OCR) in systems for automatic text analysis. Such systems first segment a document into blocks of text, such as columns. Within such blocks, lines and separate words are then identified, followed by an OCR algorithm recognizing the characters.

[0010] When several text blocks appear on a page, the logical order of the blocks, i.e. the order in which the blocks have to be read, must be determined in advance. In complex text documents, such as newspaper pages, the text blocks of one article often do not have a simple, position related order, and it may be impossible for the automatic layout analysis to find the reading order by itself.

[0011] In a system, disclosed in EP 0 415 373 A, an automatically determined reading order is indicated in a displayed image of text blocks recognised by a layout analysis section. An operator may then select one or more blocks with a cursor and change the predetermined reading order. This selection is aimed at identifying text blocks as entities in the logical structure of a text document, and is not related to the visual appearance of a specific layout element. A modification of the visual appearance is, as discussed above, related to the area or perimeter of a layout element, which is outside the scope of this prior art document.

[0012] The object of the invention is to provide an apparatus suitable for simple and rapid processing of a document image, resulting in a print with an adapted visual appearance, wherein the operator is assisted by an automatic layout analysis.

[0013] To this end, the apparatus according to claim 1 comprises

- second selection means for selecting a processing operation for changing the visual appearance of an image,

said operating means also being connected to the processing means for controlling the same in order to process a layout element selected by said first selection means, in accordance with a processing operation selected by said second selection means.

[0014] In the apparatus according to the invention, the segmentation means analyse the layout of the document, i.e., they search in the document for the separate characters, words, lines, text blocks, and also photographs, graphics, etc., and determine the mutual topographic relationship between them. It is not necessary for the segmentation means also to determine the content of the text elements and the mutual logical relationship between the layout elements.

[0015] The determined layout of the document is shown to the operator, e.g. on a display, whereupon he can select layout elements just as is done on the display of a word processor station. In these conditions the knowledge acquired of the layout helps for selection to proceed properly. For example, if the operator indicates a word, the first selection means will also select precisely that word. The operator can then specify a given processing operation which will then be carried out on the selected layout element by the processing means. Such processing operations are, for example, adaptation of the grey value scale or the colour with which the selected layout element is reproduced on the print. Especially for scanned photographs, the introduction of a raster is desirable for high-quality reproduction. When this operation is selected for a photo area, the original grey level image is converted into a dot image (as in newspaper photographs) for that area. Other processing operations come more under the heading of word processing, such as changing the orientation (rotation) and even moving a layout element. In this way the utility of the editing function is greatly increased.

[0016] The invention is also directed to an apparatus for and a method of processing a document image as claimed in claims 9 and 15.

[0017] Layout analysis of the kind taking place in the segmentation means can be performed in various ways. Two methods are described in William Lam et al: "Block Segmentation of Document Images Using the X Y Tree Approach", TR 88 14, Dept of Computer Science, SUNY Buffalo, NY, June 1988 and in Stephen W. Lam: "Reading Newspaper Text", Proc. of 10th International Conference on Pattern Recognition, New Jersey, USA, June 16 21, 1990, pp. 703 705. In addition, the inventors of the apparatus according to the invention have developed a third different method, which is described below.

[0018] In the document by William Lam et al., layout analysis of a document page is discussed by reference to two segmentation algorithms: the top down algorithm and the bottom up algorithm.

[0019] In the top down algorithm, vertical and horizontal projection profiles are made by projecting all the image dots on to the x axis or y axis respectively and counting their numbers as a function of the location on the associated axis. These profiles are used to check whether a document page can be divided into a set of layout structure elements by plane cuts. Plane cuts are permissible only if no or substantially no image dots are situated on a cutting line or band.

[0020] If each subblock of the document page formed by the cuts in one direction is again cut in the other direction in the next operation, increasingly smaller subblocks are formed until no more cuts are possible. In the case of a text page this means that the level of the individual characters has been reached.

[0021] The disadvantage of this algorithm is that for each new cut required all the image dots must be processed to determine a new projection profile, and this requires considerable computing time.

[0022] On the other hand, in the case of the bottom up algorithm, described in the publication by Stephen W. Lam, adjoining image dots are first grouped whereupon the group structures thus formed are in turn combined to form larger structures when they are closer together than a predetermined distance. This usually only takes place on the condition that the structures involved are of the same characteristic type of information, e.g. text information.

[0023] A disadvantage of the bottom up algorithm is that it can recognise the large structures only with difficulty because of its detail approach. For example, narrow boundaries which always recur at the same place in consecutive lines, are easy to recognise viewed as a whole but may be completely overlooked from the detail perspective.

[0024] Another disadvantage of such an algorithm is that a label once assigned to a group structure with respect to the characteristic type of information can no longer be changed during the segmentation process. For example, an advertising text in a photograph will be permanently regarded as text although practice shows that it is better to treat such a text as part of a photograph. Image processing operations such as enlargement or reduction, grey value adjustment, compression, etc., should of course be carried out for the entire photograph, including the text part thereof.

[0025] In the segmentation method used in the invention, however, the digital image dot information is first searched for objects formed by clusters of adjoining informationbearing image dots, and then further operations are carried out on the set of objects in order to divide the page image into blocks. This gives a considerable reduction of the number of data to be processed, so that the complete segmentation processing of a document page takes place much more rapidly than the methods known from the prior art.

[0026] In one embodiment, data relating to location, measurements and type of information (e.g. character, photograph, graphics) are determined for each object. The layout analysis, which is only logical for text areas in a document, can now be automatically restricted thereto by using for the segmenting operations only ob-

jects which represent a character.

[0027] On the other hand, some editing operations should preferably be performed on all layout elements of a specific kind. For instance, a rasterizing operation as described before should be applied on all photographs in a scanned original document. For that case, the first selection means can also be used in a generic fashion, that is, in the instance given, all photographs can be selected at once by a suitable generic command.

[0028] A document which is skew with respect to the directions used in the segmenting operations (i.e. the vertical and horizontal directions) is less satisfactorily segmented because layout elements may overlap one another. It is therefore advisable first to examine the set of objects for skewing, prior to the segmenting (cutting) operations, and if such skewing is present this should first be eliminated by moving the objects.

[0029] The invention will now be explained with reference to the accompanying drawings wherein:

Fig. 1 shows a reproduction apparatus for digital image information according to the invention,
Fig. 2 is a block diagram of the functional construction of the apparatus in Fig. 1,
Fig. 3 is a flow diagram of a method of segmenting a document page,
Fig. 4 is a diagram showing the classification procedure for object boxes,
Fig. 5 shows part of a page to be segmented,
Fig. 6 shows part of a skew text,
Fig. 7 shows a control panel of the reproduction apparatus shown in Fig. 1.

[0030] Fig. 1 shows a digital copying machine/printer 100 provided with a scanner stage 101 for electronically scanning a document, a display unit 102, an indicator element or light pen 103 for indicating locations on the display, a control panel consisting of two parts 104 and 105, and a tray 106 to receive prints, and finally a processing stage 107. The machine can be connected by a cable (not shown) to one or more external digital image dot information sources. Of course another indicator element, such as a mouse, coupled to a cursor on the display may be used instead of the light pen 103.
A touchsensitive display may also be used so that an operator can indicate the various elements with his finger.

[0031] Digital grey value image information is obtained by scanning a document in the scanner stage 101 and is stored in an internal memory. If required, image information can also be received from an external source, e.g. a computer or work station, and stored in the internal memory. The digital image information is subjected to halftoning, so that it is put into the form of a raster pattern of image dots which are white or black, and can then be printed in the processing stage 107 on a sheet of paper which is then deposited in tray 106. The construction and operation of a processing stage of this kind is public knowledge and does not form part of the invention and will not therefore be explained further.

[0032] The control panel consists of a part 104 for the normal copying and printing process and a part 105 for operating the layout analysis and image processing coupled thereto. This function will be described in detail with reference to the control means on panel 105 in Fig. 7. The part 105 of the control panel can of course also be in the form of an image made visible on the display, while the functions indicated on the panel can be selected by indicating them with the indicator element.

[0033] Fig. 2 illustrates the functional construction of the apparatus 100 in the form of a block diagram. Supply unit 201, e.g. corresponding to scanner 101, is connected to image memory 208. Also connected to memory 208 are the segmentation module 209, processing module 212 and printing unit 207, and these three elements are also connected to operating unit 211. The latter has a display 202 corresponding to display unit 102, a first selection unit 203 corresponding to indicator unit 103, a second selection unit 205 corresponding to control panel 105 and an apparatus operating unit 204 corresponding to control panel 104.
Segmentation module 209 is also connected to a memory 210.

[0034] The operation of the segmentation module 209 will first be discussed, followed by the function and operation of the other elements of the apparatus.

[0035] Fig. 3 is a flow diagram to illustrate a method of segmenting a document page.

[0036] In this flow diagram, step 2 represents the dotwise scanning of a document page.

[0037] The information obtained by scanning is digitised in step 4 to a multibit form of representation.

[0038] Steps 2 and 4 describe the generation of the image data and thus do not form part of the actual segmentation process. They have been added to give a complete picture of the total path covered by the image data through the system.

[0039] The brightness information concerning the page background is then removed from this image information in step 6, so that only the informationbearing image dots or pixels remain.

[0040] This can be effected in a number of ways. One possible way is to make a grey value histogram of the information of the entire page (or part thereof). In this histogram, a narrow tall peak situated on the light side of the histogram will represent the brightness of the background and by reference to this a threshold value is determined with which the image information is then compared dotwise. Image dots whose brightness is situated beneath the threshold value are removed, so that the background is eliminated.

[0041] In step 8 the image information is converted to binary form and stored in a memory file (bit map). This conversion is done by reference to a threshold value, for which the threshold value obtained in step 6 can be used. In that case the steps 6 and 8 can be combined.

[0042] At this moment the number of data to be processed can be reduced. Many scanners operate with a resolution of about 16 dots per millimetre (400 dpi) but this resolution often appears unnecessary for a correct segmentation. In practice, even a resolution of 2 dots per millimetre appears to give good results often enough. A reduced resolution of this kind can be obtained, for example, by making a regular selection from all the image dots, e.g. by using only a single image dot from each block of 8 x 8 image dots, i.e. storing it in the bit map. The further procedure described hereinafter is then performed on the reduced image dot set. It will be clear that this gives a considerable gain in processing speed.

[0043] Step 10 then searches for clusters of connected pixels, i.e. image dots which adjoin one another or which are connected through the agency of one or more adjoining image dots. A cluster of this kind is hereinafter referred to as "object".

[0044] This can be carried out, for example, as an iterative process, each search covering image dots adjoining an image dot in a 3 x 3 image dot environment.

[0045] At the same time, hence in the same step, a rectangular frame or "object box" is defined for each object of connected image dots to enclose the object. The sides of this frame are parallel to the horizontal and vertical direction (the X and Y directions respectively in the document page). The position of each box thus found is stored in a memory file (the object file) in the form of the coordinates of the top left and bottom right corner points. The number of informationbearing image dots situated therein is also stored for each box.

[0046] In the next step 12, each box is assigned a label, its dimensions and the number of image dots situated therein determining whether the object in the box relates to a character, photograph, graphics, line or noise.

[0047] This classification is based on a number of empirical rules which appear to be adequate in practice. All the possibilities are traversed in a graduated test procedure shown in Fig. 4. The consecutive tests are indicated by an encircled T. Two arrows extend from each test, the arrow to the left being applicable if the test gives an affirmative answer and the arrow to the right in the event of a negative answer.

[0048] The tests make use of a reference measurement defined as the height of a font (character set) somewhat larger than the font normally used for texts, namely 12point. If a text with an abnormally large font is analysed, then the reference measurement must be adjusted, but in practice the same font size is used for a considerable amount of printed matter so that the reference measurement selected is in most cases adequate.

[0049] Test T1 checks whether the ratio of the longest and shortest side of the object box under examination is large and also whether the shortest side is smaller than half the reference measurement. If so, the object box is given the label "line" (l).

[0050] Test T2 determines the degree of coverage of the object box, i.e. the number of informationbearing image dots divided by the total number of image dots in the object box. If this is very low, the object box is classified as "graphics" (g). Object boxes clearly larger than the reference measurement and having a relatively low degree of coverage are also classified as "graphics".

[0051] In test T3 the remaining object boxes are divided into small object boxes (half as large as the reference measurement) and large object boxes.

[0052] In test T4 the small object boxes are divided into "noise" (n) (if they are very small) and "character" (k).

[0053] The large object boxes of test T3 are checked for their measurements in test T5. Very large object boxes (more than three times as large as the reference measurement) are assigned the label "photograph" (f).

[0054] In test T6 the remaining large object boxes which are smaller than the reference measurement in one direction and somewhat larger in the other direction are provided with the label "character" (k). These are presumably two characters stuck together.

[0055] The last remaining object boxes are divided in test T7 into (small) photographs (f) if their degree of coverage is very high, and (large) characters (k).

[0056] Some corrections are performed on the classification results in the following steps 14, 16 and 18.

[0057] Step 14: A character object whose box overlaps a box of a photoobject is reclassified as a photoobject. This prevents texts in a photograph from undergoing a different image processing operation from the photoobjects.

[0058] Step 16: When a document page contains one or more bar codes, it is possible, during the classification, that some of the lines are classified as line objects but that the others are classified as character objects. If, in a set of a minimum number of consecutive objects, positioned horizontally or vertically, of the character type, on the one hand, and of the line type, on the other hand, at least a predetermined number of line objects occurs, then a reclassification of objects takes place such that each object in this set is classified as a line object.

[0059] Step 18: Very small object boxes which, however, are just too large to be eliminated as noise in test T4, are divided up into small objects with significant information (such as dots and diaereses, etc., above letters and dots as part of a punctuation mark) and small objects without meaning, such as noise dots. The test criterion here is whether a character box is found within a predetermined small distance from such a small object. If so, this small object and the character box thus found are combined to form a new character box.

[0060] Step 20 then checks whether the image information originates from a skew original. This term is used to indicate that the document page to which the image data relate is rotated through a certain angle. This angle

is termed the skew angle.

[0061] An accurate method of determining the skew angle based on the recognition of the lefthand margin of the text on the document page will be explained hereinafter with reference to Fig. 6.

[0062] In the event of a skew angle, the next step 22 reorients the set of object boxes. Reorientation of the boxes is effected by rotating about a fixed point the top left corner point of each object box through an angle which is the opposite of the skew angle. The other corner points of such an object box undergo identical displacement so that the orientation of an object box does not change during this translation.

[0063] Step 22 completes the phase of the method for constructing a set of correctly oriented object boxes with an associated object label from a bit map.

[0064] The objects classified as character are selected in step 24, step 26 then determining text blocks, lines and words in producing a layout structure of the text part. The selection of just the character boxes means that other object boxes are simply cancelled out in this determination and cannot thus act as a disturbing factor to frustrate the determination of the layout structure.

[0065] In step 26 the document page is cut, so that it is divided into rectangles by applying cuts alternately in the X direction or the Y direction. Starting with the smallest rectangle in which all the character objects fall (the page block), each block is split into smaller blocks at places where cuts can be made in the X or Y direction. A cut in the X direction in a block to be cutted is placed where a horizontal area occurs with a defined width within which there is no single character object.

[0066] Similarly, a cut in the Y direction is made in a block where there is a vertical area of a certain width in which there is no single character object. The cuts in the X and Y directions are performed alternately. Thus a block formed as a result of a horizontal cut is then cut vertically. If no cuts can be made in the X and Y directions in a block, an end block is found. By varying the width that a cut must satisfy an end block of this kind can represent a paragraph, line of text, word or character. It should be noted that when starting to search for possible places for making cuts a search must first be made in a given, e.g. horizontal, direction and then in the vertical direction, even if no cut was possible in the horizontal direction, such as may occur, for example, in the case of text arranged in columns.

[0067] Determination of, for example, a vertical cut in a block B will now be explained with reference to Fig. 5.

[0068] The document page P on which the block B occurs is formed by character object boxes b(i), with i running from 0 (the top left corner) up to and including n (the bottom righthand corner of the page). The coordinates of the top left and bottom right corners of each box are stored in an object file in the memory.

[0069] The block B is formed by the object boxes b(j), with j running from p to q and p and q both being situated between 0 and n.

[0070] The object boxes of the block B are first sorted by ascending X-coordinate from their top left corner and for a constant X-coordinate by ascending Y-coordinate from their top left corner. Standard algorithms are available for this. The resulting series in which the object boxes are further indicated by b'(i), thus starts with the box situated furthest to the left and, if different boxes have exactly the same X-coordinate, the topmost of those boxes.

[0071] For each following object box from the series, the smallest enveloping rectangle O of the series is then determined, i.e. the rectangle with sides parallel to the x and y axis which just contains all the object boxes of the series, and then the horizontal distance w of the lefthand side of said object box and the enveloping rectangle associated with the previous object box is also calculated.

[0072] If the distance w is not greater than a predetermined critical value W, the enveloping rectangle O is extended so that it also contains the new object box, whereupon the following object box is considered. If the distance w, on the other hand, is larger than the critical value W, then the enveloping rectangle associated with the previous object box, O, is closed and a new enveloping rectangle O' is formed around the new object box. This is shown in Fig. 5, where b'(j) is the last object box of enveloping rectangle O and object box b'(j+1) is a horizontal distance w, larger than W, away from the enveloping rectangle O. The closed enveloping rectangle O is then handled as a subblock of block B.

[0073] In this way the block B is divided into one or more adjoining subblocks. As a result of the described prior sorting the processing sequence of the object boxes is optimal so that the division into subblocks takes place very rapidly.

[0074] After division of block B into subblocks by means of vertical cuts, each subblock is in turn divided into smaller blocks by means of horizontal cuts. This proceeds in a similar manner to that described for vertical cuts, as follows:

[0075] The procedure for the horizontal cutting of the subblock O from the abovedescribed division operation again starts with sorting the object boxes of the subblock, now by ascending Y-coordinate of their top left corner, and, for constant Y-coordinate, by ascending X-coordinate of their top left corner. The resulting series of object boxes thus starts with the top box, and if different boxes have exactly the same Y-coordinate, the furthest left of those boxes.

[0076] The smallest enveloping rectangle of the series is then determined for each following object box of the series, and the vertical distance h between the bottom of that object box and the enveloping rectangle associated with the previous object is also calculated. If the distance h is not larger than a predetermined critical value H, the enveloping rectangle is extended to include the new object box as well, whereupon the following object box is considered.

[0077] If, on the other hand, the distance h is larger than the critical value H, the enveloping rectangle associated with the previous object box is closed and a new enveloping rectangle is formed around the new object box. The closed enveloping rectangle is then handled as a subblock of subblock O.

[0078] The choice of the critical values W and H governs the result of the cuts and should be adapted to the level of the cut and to the size of the object boxes. For example, when a document page is divided into text columns, the value of W can be selected as being three times the average width of the object boxes, and for division of a line of text into words one and a half times the average distance between the boxes in the line (this can be calculated per line during the procedure). These values are determined by experiment.

[0079] The cuts in the X and Y directions also govern the corner points of the layout structure of a document page, such as paragraphs, text columns, lines, etc. The resulting layout structure can then be represented hierarchically in accordance with a tree structure.

[0080] The method of determining whether the image data originates from a skew document and, if so, the magnitude of the skew angle, will now be discussed in detail with reference to Fig. 6. This method is used in step 20 in Fig. 3.

[0081] The method determines the position of the lefthand margin and in so doing uses the object boxes of the "character" type in the object box file. This file contains all the object boxes with the coordinates of their top left and bottom right corner. Where the following description refers to a box, it denotes a character object box.

[0082] The method takes place in three phases:

- searching for the box situated furthest left in each line
- selecting from this set those boxes which really belong to the margin
- calculating the skew angle from the direction of the margin.

[0083] Once the skew angle has been determined, the object box file can be transformed so that the data therein relate to an aligned document.

[0084] The first phase of the method starts with sorting the boxes by ascending X-coordinate and, for a constant X-coordinate, by ascending Y-coordinate, of their top left corner. This is shown in Fig. 6, where part of a skew text is shown rotated in the anticlockwise direction. Each character is provided with a box and a number of boxes is numbered I1 to I7, in the sequence in which they are sorted.

[0085] The boxes are then read out and included in the same sequence in a list provided they have no overlap with a box already included in the list previously or with the white space between that box and the box thereabove. This is effected by comparing the segment on the Y-axis occupied by the new box with the segments on the Y-axis which are always limited by the Y-coordinate of the bottom righthand corner of a given box already included, and that of the bottom righthand corner of the already included box situated directly thereabove. Since the second and following characters of a line always overlap the first character, even in the event of a skew position, and can thus be eliminated, on completion the list will only contain the first box of each line. The first elements of the list are now thus formed by the boxes I1, I2, I3, I4, I5, I7, etc., in Fig. 6, since box I6 overlaps box I1 and is thus not included in the list.

[0086] The boxes in the list are then resorted, now by ascending value of the Y-coordinate of their top lefthand corner. They are then read out from the list one by one and the direction vector from their top left corner to the top left corner of the next box from the list is calculated from the differences dx, dy of their X and Y coordinates. This is shown in Fig. 6, where the arrows always represent the direction vectors. This direction vector is now compared with that of the preceding box, and if its direction does not deviate therefrom by more than a value V, there is a chance that a margin has been found. There can incidentally be more than one margin on a page, e. g. in the case of an indented paragraph. Starting from a predetermined maximum permissible deviation in the X-direction between two characters situated at corresponding positions in two consecutive text lines, the value V is recalculated for each box as a function of the difference in Y-coordinate between the two boxes between which the direction vector is calculated.

[0087] The idea underlying this is as follows. Even when a text is completely aligned, there may be small differences in X-position between two characters situated one under the other. These differences are increased by a skew position. This is the result of differences in form. The maximum deviation is made the same for all lines, e.g. 3 image dots. On the basis of a line spacing, for example, of 35 image dots the maximum deviation is then 4.9 for two consecutive lines, but only 1.6 over three lines. The value of V will thus be smaller in proportion as the two boxes between which the direction vector is calculated are farther away from one another in the Y-direction.

[0088] After the analysis of the boxes in the list, a search is then made for the longest row of boxes whose direction vectors are equal within the tolerance V and this is then considered as (part of) the margin. From the two end points of the row a search is then made for other boxes situated outside the row and also situated on the margin. This would apply, for example, if there is an indented paragraph in the middle of a page. There are then two page parts, above and below the indented paragraph, situated on the same margin. The direction vector is first determined from the bottommost box of the row to the box beneath it and a check is made whether it is equal, within the tolerance V, to that applicable to the margin boxes. If that is not so (and it will certainly

be so for the first box examined), then the box beneath it is tested, and so on, till a box is found whose direction vector does come within the tolerance V. This box is again situated on the margin and is therefore included in the row of margin boxes. Similarly, a search is made in the other direction from the row of margin boxes for other margin boxes.

[0089] When all the margin boxes have been found, a straight line is drawn through their top left corners (e. g. by means of the smallest square method) and the skew is calculated from the direction of the straight line. In practice, it is possible with this method to determine a skew accurately to approximately 0.2 .

[0090] The processing of the image data in memory 208 (Fig. 2), in connection with the layout analysis, will now be discussed with reference to Fig. 7, which shows the control panel 105.

[0091] After the digital image information of a document (page) has been stored in the internal memory 208 of the apparatus, it is automatically segmented by segmentation module 209. The resulting layout structure is also stored in memory 210. This structure contains the locations of all the character object boxes, and of all the higher elements formed by the text object boxes, such as blocks, lines and words, in addition to the locations and type of all the other object boxes.

[0092] An image of the document, on which the object boxes are also drawn, is then shown, reduced if required, on the display of the display unit 102. Using the light pen 103, the operator can now indicate elements on the display. He can indicate which element he wishes to select by one of the keys on the control panel 105 (Fig. 5) under the heading SELECTION LEVEL. If the operator presses the WORD key and indicates a (text) object box with the light pen, then memory 210 searches for the element of the "word" type, of which the indicated object box forms part. This element then appears on the display in framed form or otherwise conspicuously. Similarly, the keys BLOCK and LINE refer to elements of the "block" and "line" type respectively while OBJECT and PAGE refer to a single object box and the whole page respectively. Finally, the AREA key can be used to select a rectangular frame whose dimensions follow the movement of the light pen (known as "rubber banding" in personal computer technology).

[0093] Once a layout element has been selected, it can be processed by processing module 212, from the series indicated under the heading OPERATION on the right of the control panel.

[0094] If SET COLOUR is selected, the selected element is printed in a different colour. The UP and DOWN keys can be used to make a choice from a number of available colours. Information as to the possible choices then appears on the display. The processing module 212 then places a code in the memory 208 at the image dot data of the selected layout element, to instruct the printing unit 207 to print the relevant part of the image in the required colour.

[0095] The SET CONTRAST operation can be used to control the reproduction characteristic (gradation) of the print for the selected element, the UP and DOWN keys making the reproduction harder and softer respectively. This is important, for example, if the original image is not sufficiently contrasty to give a clear image. In that case the processing module 212 selects a different conversion function from grey value image data to binary (white/black) image data for printing purposes during the halftoning operation.

[0096] The selected document can be enlarged or reduced with the RESIZE operation (using the UP and DOWN keys), while INVERT is used to print it in negative form and ROTATE is used to rotate it in the image (the angle of rotation can be selected with the UP and DOWN keys).

[0097] The CUT & PASTE heading contains keys for carrying out operations at the location of a selected document. In the case of DUPLICATE, a selected element is copied at the place indicated by the light pen. With MOVE a selected element can be moved ("dragged") across the display while a selected element can be removed from the image with REMOVE.

[0098] Finally, the heading INCLUDE contains the keys LOAD for loading image data from an external source, and CREATE PAGE for compiling a document page, for which it is possible to use the keys from the CUT & PASTE heading. In the case of this last function, an empty page image is shown on the display next to the page already selected and layout elements from the selected page can be transferred to the empty page in order thus to compile a new image, e.g. a clippings newssheet.

[0099] The abovedescribed functions are performed by a computer accommodated in the reproduction apparatus. The programming required for the processing of layout elements is quite well known from computer and PC technology and is therefore not explained in detail here.

[0100] The invention has been explained with reference to the above description of an embodiment, but it will be clear to the skilled man that other embodiments also come within the scope of the following claims.

Claims

1. Apparatus for reproducing an image, comprising

   - means (201) for supplying digital image dot information representing said image,
   - a memory (208) for storing image dot information,
   - means (212) for processing the supplied image dot information,
   - means (207) for printing the processed image dot information on an image support,
   - segmentation means (209), connected to the

memory (208), for automatically making a layout-analysis of the image and correspondingly segmenting the digital image dot information into layout elements,

- operating means (211), connected to the segmentation means for receiving therefrom results of the segmentation and being provided with:

  - means (202) for displaying said results to an operator,
  - first selection means (203) for selecting one or more layout elements found during the segmentation, and

- second selection means (205) for selecting a processing operation for changing the visual appearance of an image,

said operating means (211) also being connected to the processing means (212) for controlling the same in order to process a layout element selected by said first selection means (203), in accordance with a processing operation selected by said second selection means (205).

2. Apparatus according to claim 1, wherein the processing operation comprises changing the grey value scale.

3. Apparatus according to claim 1, wherein the processing operation comprises changing the colour in the print on the image support.

4. Apparatus according to claim 1, wherein the processing operation comprises the introduction of a raster.

5. Apparatus according to claim 1, wherein the processing operation comprises changing the orientation.

6. Apparatus according to claim 1, wherein the processing operation comprises changing the location.

7. Apparatus according to claim 6, wherein the said processing operation for changing the location of a selected layout element comprises transferring said one or more layout elements to a separate image displayed on said displaying means (202).

8. Apparatus according to claim 6 or 7, wherein the said processing operation for changing the location of a selected layout element comprises copying said layout element into a separate image displayed on said displaying means (202).

9. Apparatus for processing digital image dot information representing an image, comprising

- means (201) for supplying digital image dot information representing said image,
- a memory (208) for storing image dot information,
- means (212) for processing the supplied image dot information,
- segmentation means (209), connected to the memory (208), for automatically segmenting the digital image dot information into layout elements,
- operating means (211), connected to the segmentation means for receiving therefrom results of the segmentation, and being provided with:

  - means (202) for displaying said results to an operator,
  - first selection means (203) for selecting one or more layout elements found during the segmentation, and

- third selection means (205) for selecting a transfer operation for transferring a layout element to another location,

said operating means (211) also being connected to the processing means for controlling the same in processing digital image dot information representing a layout element selected by said first selection means (203), in accordance with a transfer operation selected by said third selection means (205).

10. Apparatus in accordance with claim 9, wherein said processing means (212) includes means for creating a receiving image, and means for copying or transferring a selected layout element thereto.

11. Apparatus in accordance with claim 10, wherein said operating means (211) includes a so-called "cut & paste" function, for an operator to command a copy or transfer operation of a selected layout element to said receiving image.

12. Apparatus in accordance with claim 10, wherein said means (202) for displaying said image displays the same together with said receiving image.

13. Apparatus in accordance with claim 10 or 12, wherein the processing means (212) is adapted to compile a receiving image from layout elements transferred or copied thereto.

14. Apparatus in accordance with claim 9, also including printing means (207) connected to said processing means (212) for printing digital image dot infor-

mation representing a selected layout element, on an image support.

15. Method of processing a document image, comprising the following steps:

- having digital image dot information representing said image,
- automatically segmenting said digital image dot information into layout elements,
- presenting said image to an operator for selection of one or more of the layout elements found in the segmenting step,
- presenting for selection, to an operator, at least one transfer operation for transferring a layout element to another location,
- processing digital image dot information representing a selected layout element, in accordance with a selected transfer operation.

16. Method according to claim 15, also comprising the step of creating a receiving image, wherein said step of processing comprises copying or transferring a selected layout element to said receiving image.

17. Method according to claim 16, further including displaying said receiving image to an operator.

18. Method according to claim 16, further including compiling a receiving image from layout elements transferred or copied thereto.

19. Method according to any of claim 15, wherein said digital image dot information representing layout elements selected by the operator is outputted to a printer.

Patentansprüche

1. Vorrichtung zur Wiedergabe eines Bildes, mit

- einer Einrichtung (201) zum Zuführen digitaler Bildpunktinformation, die das Bild repräsentiert,
- einem Speicher (208) zum Speichern der Bildpunktinformation,
- einer Einrichtung (212) zum Verarbeiten der zugeführten Bildpunktinformation,
- einer Einrichtung (207) zum Drucken der verarbeiteten Bildpunktinformation auf einem Bildträger,
- einer mit dem Speicher (208) verbundenen Segmentiereinrichtung (209) zum automatischen Durchführen einer Layoutanalyse des Bildes und zum entsprechenden Segmentieren der digitalen Bildpunktinformation in Layoutelemente,
- einer Bedieneinrichtung (211), die mit der Segmentiereinrichtung verbunden ist, um Resultate der Segmentierung von ihr zu erhalten, und die aufweist:
- eine Einrichtung (202) zum Anzeigen der Resultate für eine Bedienungsperson,
- eine erste Wähleinrichtung (203) zum Auswählen eines oder mehrerer Layoutelemente, die bei der Segmentierung gefunden wurden, und
- einer zweiten Wähleinrichtung (205) zum Auswählen einer Verarbeitungsoperation zum Ändern des Aussehens eines Bildes,

wobei die Bedieneinrichtung (211) auch mit der Verarbeitungseinrichtung (212) verbunden ist, um diese anzusteuern, damit sie ein durch die erste Wähleinrichtung (203) ausgewähltes Layoutelement in Übereinstimmung mit einer durch die zweite Wähleinrichtung (205) ausgewählten Verarbeitungsoperation verarbeitet.

2. Vorrichtung nach Anspruch 1, bei der die Verarbeitungsoperation das Ändern der Grauwertskala umfaßt.

3. Vorrichtung nach Anspruch 1, bei der die Verarbeitungsoperation das Ändern der Farbe des Druckes auf dem Bildträger umfaßt.

4. Vorrichtung nach Anspruch 1, bei der die Verarbeitungsoperation das Einführen eines Rasters umfaßt.

5. Vorrichtung nach Anspruch 1, bei der die Verarbeitungsoperation das Ändern der Orientierung umfaßt.

6. Vorrichtung nach Anspruch 1, bei der die Verarbeitungsoperation das Ändern des Ortes umfaßt.

7. Vorrichtung nach Anspruch 6, bei der die Verarbeitungsoperation zum Ändern des Ortes eines gewählten Layoutelements das Übertragen des einen oder mehrerer Layoutelemente auf ein separates Bild umfaßt, das auf der Anzeigeeinrichtung (202) angezeigt wird.

8. Vorrichtung nach Anspruch 6 oder 7, bei der die Verarbeitungsoperation zum Ändern des Ortes ei-

nes ausgewählten Layoutelements das Kopieren des Layoutelements in ein separates Bild umfaßt, das auf der Anzeigeeinrichtung (202) angezeigt wird.

9. Vorrichtung zum Verarbeiten von ein Bild repräsentierender digitaler Bildpunktinformation, mit

- einer Einrichtung (201) zum Zuführen von digitaler Bildpunktinformation, die das Bild repräsentiert,
- einem Speicher (208) zum Speichern der Bildpunktinformation,
- einer Einrichtung (212) zum Verarbeiten der zugeführten Bildpunktinformation,
- einer mit dem mit dem Speicher (208) verbundenen Segmentiereinrichtung (209) zum automatischen Segmentieren der digitalen Bildpuktinformation in Layoutelemente,
- einer Bedieneinrichtung (211), die mit der Segmentiereinrichtung verbunden ist, um Resultate der Segmentierung von ihr zu empfangen, und die aufweist:
- eine Einrichtung (202) zur Anzeige dieser Resultate für eine Bedienungsperson,
- eine erste Wähleinrichtung (203) zum Auswählen eines oder mehrerer Layoutelemente, die bei der Segmentierung gefunden wurden, und
- eine dritte Wähleinrichtung (205) zum Auswählen einer Übertragungsoperation zum Übertragen eines Layoutelementes an einen anderen Ort,

wobei die Bedieneinrichtung (211) auch mit der Verarbeitungseinrichtung verbunden ist, um diese zu steuern, damit sie digitale Bildpunktinformation, die ein durch die erste Wähleinrichtung (203) ausgewähltes Layoutelement repräsentiert, in Übereinstimmung mit einer durch die dritte Wähleinrichtung (205) ausgewählten Übertragungsoperation verarbeitet.

10. Vorrichtung nach Anspruch 9, bei der die Verarbeitungseinrichtung (212) eine Einrichtung zum Erzeugen eines empfangenden Bildes und eine Einrichtung zum Kopieren oder Übertragen eines ausgewählten Layoutelements dorthin aufweist.

11. Vorrichtung nach Anspruch 10, bei der die Bedieneinrichtung (211) eine sogenannte "Ausschneiden & Einsetzen "-Funktion aufweist, mit der eine Bedienungsperson eine Kopier- oder Übertragungsoperation eines ausgewählten Layoutelements in das empfangende Bild befehlen kann.

12. Vorrichtung nach Anspruch 10, bei der die Einrichtung (202) zur Anzeige des Bildes dieses Bild zusammen mit dem empfangenden Bild anzeigt.

13. Vorrichtung nach Anspruch 10 oder 12, bei der die Verarbeitungseinrichtung (212) dazu ausgebildet ist, ein empfangendes Bild aus Layoutelementen zusammenzustellen, die dorthin übertragen oder kopiert wurden.

14. Vorrichtung nach Anspruch 9, mit einer Druckeinrichtung (207), die mit der Verarbeitungseinrichtung (212) verbunden ist, zum Drucken von digitaler Bildpunktinformation, die ein ausgewählten Layoutelement repräsentiert, auf einen Bildträger.

15. Verfahren zur Verarbeitung eines Vorlagenbildes, mit den folgenden Schritten:

- Gewinnen digitaler Bildpunktinformation, die das Bild repräsentiert,
- automatisches Segmentieren dieser digitalen Bildpunktinformation in Layoutelemente,
- Darbieten des Bildes an eine Bedienungsperson zur Auswahl eines oder mehrerer Layoutelemente, die im Segmentierungsschritt gefunden wurden,
- Darbieten wenigstens einer Übertragungsoperation, zur Auswahl durch eine Bedienungsperson, zum Übertragen eines Layoutelements an einen anderen Ort,
- Verarbeiten digitaler Bildpunktinformation, die ein ausgewähltes Layoutelement repräsentiert, in Übereinstimmung mit einer ausgewählten Übertragungsoperation.

16. Verfahren nach Anspruch 15, mit dem Schritt der Erzeugung eines empfangenden Bildes, wobei der Schritt der Verarbeitung das Kopieren oder Übertragen eines ausgewählten Layoutelements in dieses empfangende Bild umfaßt.

17. Verfahren nach Anspruch 16, das das Anzeigen des empfangenden Bildes für eine Bedienungsperson einschließt.

18. Verfahren nach Anspruch 16, das das Zusammenstellen eines empfangenden Bildes aus dorthin übertragenen oder kopierten Layoutelementen einschließt.

19. Verfahren nach einem der Ansprüche 15, bei dem die digitale Bildpunktinformation, die durch die Bedienungsperson ausgewählte Layoutelemente repräsentiert, an einen Drucker ausgegeben wird.

Revendications

1. Appareil pour reproduire une image, comprenant

   - des moyens (201) pour fournir des informations numériques de points d'image représentant ladite image,
   - une mémoire (208) pour stocker des informations de points d'image,
   - des moyens (212) pour traiter les informations fournies de points d'image,
   - des moyens (207) pour imprimer les informations traitées de points d'image sur un support d'image,
   - des moyens (209) de segmentation, reliés à la mémoire (208), pour effectuer automatiquement une analyse de disposition de l'image et segmenter en conséquence les informations numériques de points d'image en des éléments de disposition,
   - des moyens (211) d'exploitation, reliés aux moyens de segmentation, pour en recevoir des résultats de la segmentation et étant munis de :

     - moyens (202) pour afficher lesdits résultats à un opérateur,
     - premiers moyens (203) de sélection pour sélectionner un ou plusieurs éléments de disposition trouvés pendant la segmentation, et
     - deuxièmes moyens (205) de sélection pour sélectionner une opération de traitement pour modifier l'apparence visuelle d'une image,

   lesdits moyens (211) d'exploitation étant reliés aussi aux moyens (212) de traitement pour commander ceux-ci afin de traiter un élément de disposition sélectionné par lesdits premiers moyens (203) de sélection, en fonction d'une opération de traitement sélectionnée par lesdits deuxièmes moyens (205) de sélection.

2. Appareil selon la revendication 1, dans lequel l'opération de traitement comprend une modification de l'échelle de valeurs de gris.

3. Appareil selon la revendication 1, dans lequel l'opération de traitement comprend une modification de la couleur dans l'impression sur le support d'image.

4. Appareil selon la revendication 1, dans lequel l'opération de traitement comprend l'introduction d'une trame.

5. Appareil selon la revendication 1, dans lequel l'opération de traitement comprend un changement de l'orientation.

6. Appareil selon la revendication 1, dans lequel l'opération de traitement comprend un changement de l'emplacement.

7. Appareil selon la revendication 6, dans lequel ladite opération de traitement pour un changement de l'emplacement d'un élément sélectionné de disposition comprend un transfert desdits un ou plusieurs éléments de disposition vers une image séparée affichée sur lesdits moyens (202) d'affichage.

8. Appareil selon la revendication 6 ou 7, dans lequel ladite opération de traitement pour un changement de l'emplacement d'un élément sélectionné de disposition comprend une copie dudit élément de disposition dans une image séparée affichée sur lesdits moyens (202) d'affichage.

9. Appareil pour traiter des informations numériques de points d'image représentant une image, comprenant

   - des moyens (201) pour fournir des informations numériques de points d'image représentant ladite image,
   - une mémoire (208) pour stocker des informations de points d'image,
   - des moyens (212) pour traiter les informations fournies de points d'image,
   - des moyens (209) de segmentation, reliés à la mémoire (208), pour segmenter automatiquement les informations numériques de points d'image en des éléments de disposition,
   - des moyens (211) d'exploitation, reliés aux moyens de segmentation, pour en recevoir des résultats de la segmentation et étant munis de :

     - moyens (202) pour afficher lesdits résultats à un opérateur,
     - premiers moyens (203) de sélection pour sélectionner un ou plusieurs éléments de disposition trouvés pendant la segmentation, et
     - troisièmes moyens (205) de sélection pour sélectionner une opération de transfert afin de transférer un élément de disposition vers un autre emplacement,

   lesdits moyens (211) d'exploitation étant reliés aussi aux moyens de traitement pour commander ceux-ci afin de traiter des informations numériques de

points d'image représentant un élément de disposition sélectionné par lesdits premiers moyens (203) de sélection, en fonction d'une opération de transfert sélectionnée par lesdits troisièmes moyens (205) de sélection.

10. Appareil selon la revendication 9, dans lequel lesdits moyens (212) de traitement comprennent des moyens pour créer une image de réception, et des moyens pour y copier ou transférer un élément sélectionné de disposition.

11. Appareil selon la revendication 10, dans lequel lesdits moyens (211) d'exploitation comprennent ce qu'on appelle une fonction "couper et coller", pour qu'un opérateur ordonne une opération de copie ou de transfert d'un élément sélectionné de disposition vers ladite image de réception.

12. Appareil selon la revendication 10, dans lequel lesdits moyens (202) pour afficher ladite image l'affichent en même temps que ladite image de réception.

13. Appareil selon la revendication 10 ou 12, dans lequel les moyens (212) de traitement sont conçus pour compiler une image de réception à partir d'éléments de disposition qui y sont transférés ou copiés.

14. Appareil selon la revendication 9, comprenant en outre des moyens (207) d'impression reliés auxdits moyens (212) de traitement pour imprimer, sur un support d'image, des informations numériques de points d'image représentant un élément sélectionné de disposition.

15. Procédé pour traiter une image de document, comprenant les étapes suivantes :

- obtenir des informations numériques de points d'image représentant ladite image,
- segmenter automatiquement lesdites informations numériques de points d'image en des éléments de disposition,
- présenter ladite image à un opérateur pour une sélection d'un ou de plusieurs des éléments de disposition trouvés dans l'étape de segmentation,
- présenter à un opérateur, pour une sélection, au moins une opération de transfert afin de transférer un élément de disposition à un autre emplacement,
- traiter des informations numériques de points d'image représentant un élément sélectionné de disposition, en fonction d'une opération sélectionnée de transfert.

16. Procédé selon la revendication 15, comprenant en outre l'étape consistant à créer une image de réception, dans lequel ladite étape de traitement comprend une copie ou un transfert d'un élément sélectionné de disposition vers ladite image de réception.

17. Procédé selon la revendication 16, comprenant en outre d'afficher ladite image de réception à un opérateur.

18. Procédé selon la revendication 16, comprenant en outre de compiler une image de réception à partir d'éléments de disposition qui y sont transférés ou copiés.

19. Procédé selon la revendication 15, dans lequel lesdites informations numériques de points d'image représentant des éléments de disposition sélectionnés par l'opérateur sont envoyées à une imprimante.

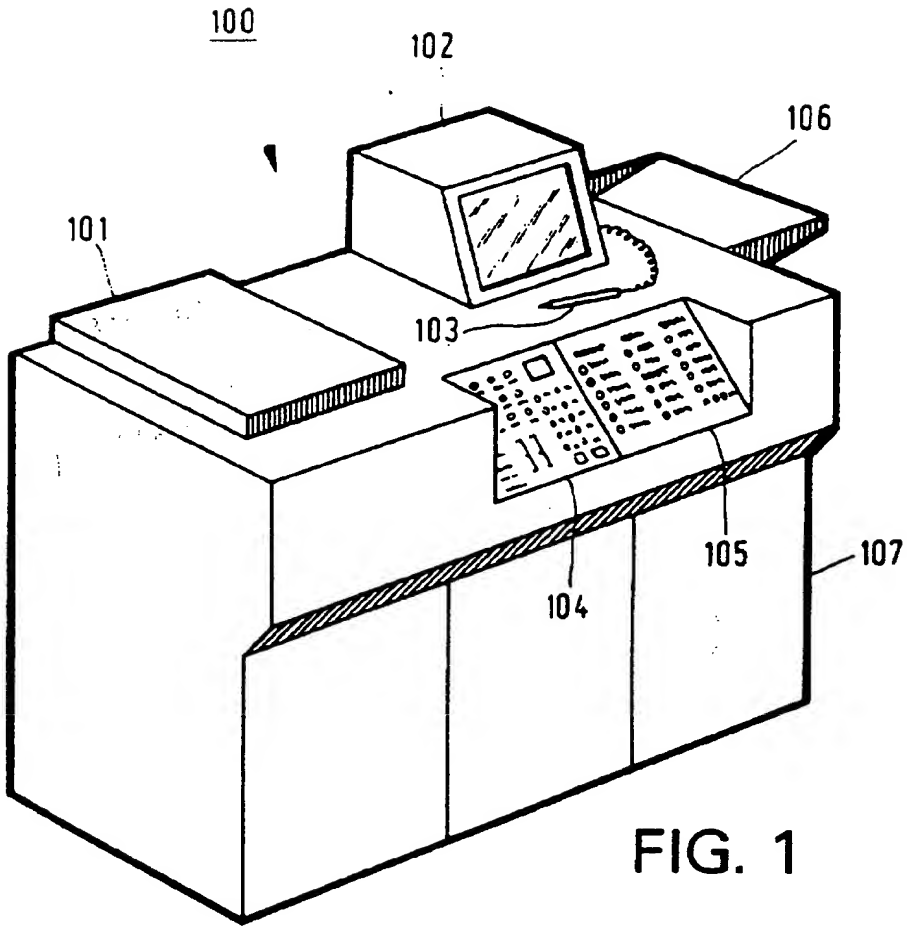

FIG. 1

SELECTION LEVEL	INCLUDE	OPERATION
○ OBJECT	○ LOAD	○ SET COLOR
○ BLOCK	○ CREATE PAGE	○ SET CONTRAST
○ LINE	CUT & PASTE	○ RESIZE
○ WORD	○ DUPLICATE	○ INVERT
○ AREA	○ MOVE	○ ROTATE
○ PAGE	○ REMOVE	UP ○ ○ DOWN

FIG. 7

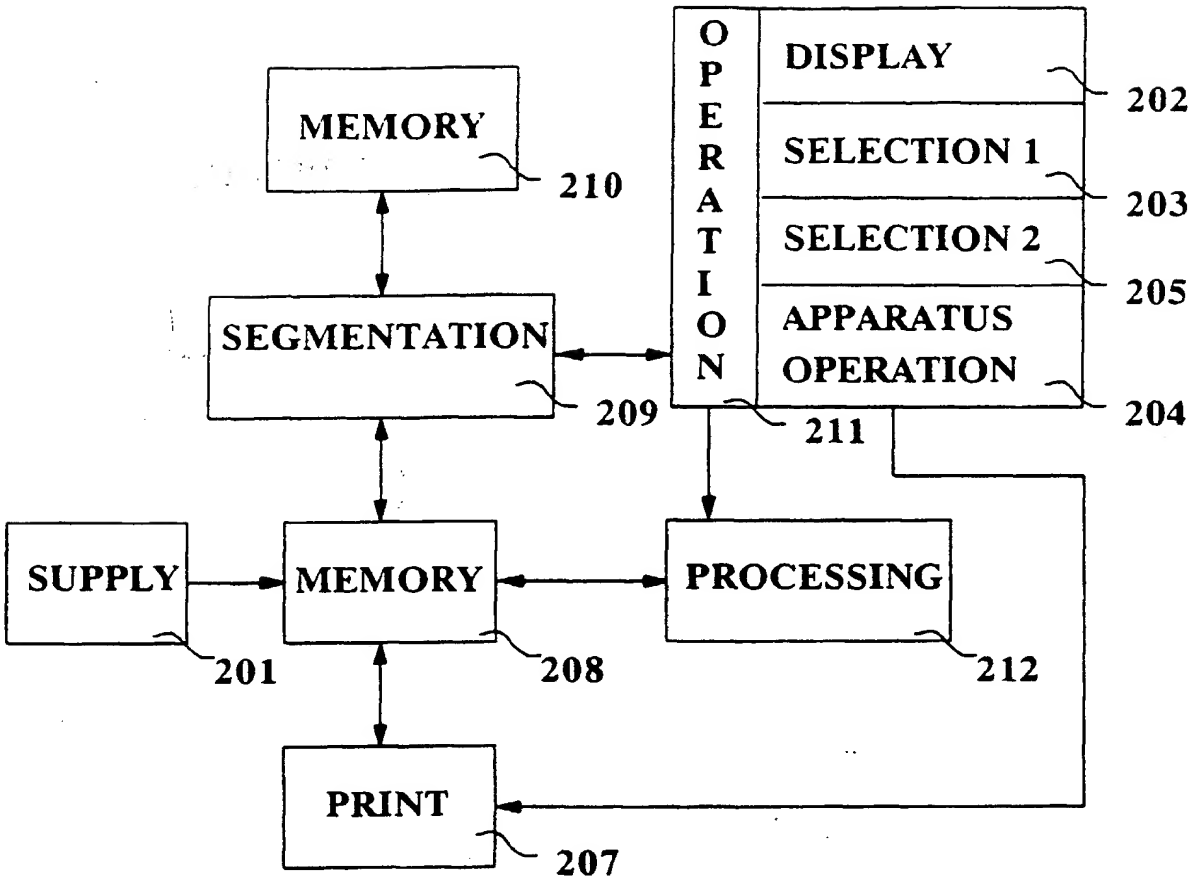
MEMORY
210
SEGMENTATION
209
OPERATION
DISPLAY
202
SELECTION 1
203
SELECTION 2
205
APPARATUS OPERATION
204
211
SUPPLY
201
MEMORY
208
PROCESSING
212
PRINT
207

FIG. 2

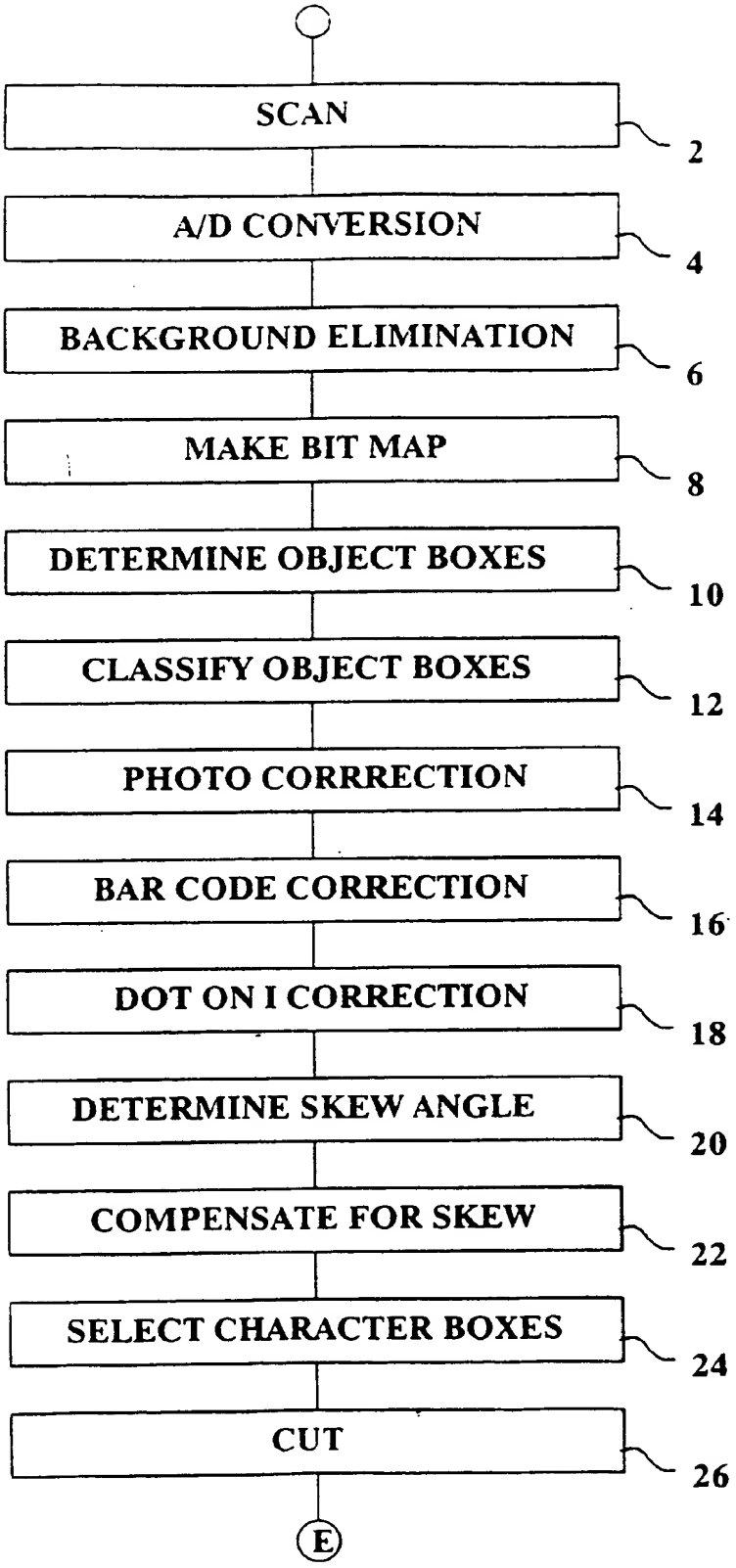
SCAN
2
A/D CONVERSION
4
BACKGROUND ELIMINATION
6
MAKE BIT MAP
8
DETERMINE OBJECT BOXES
10
CLASSIFY OBJECT BOXES
12
PHOTO CORRRECTION
14
BAR CODE CORRECTION
16
DOT ON I CORRECTION
18
DETERMINE SKEW ANGLE
20
COMPENSATE FOR SKEW
22
SELECT CHARACTER BOXES
24
CUT
26
E

FIG. 3

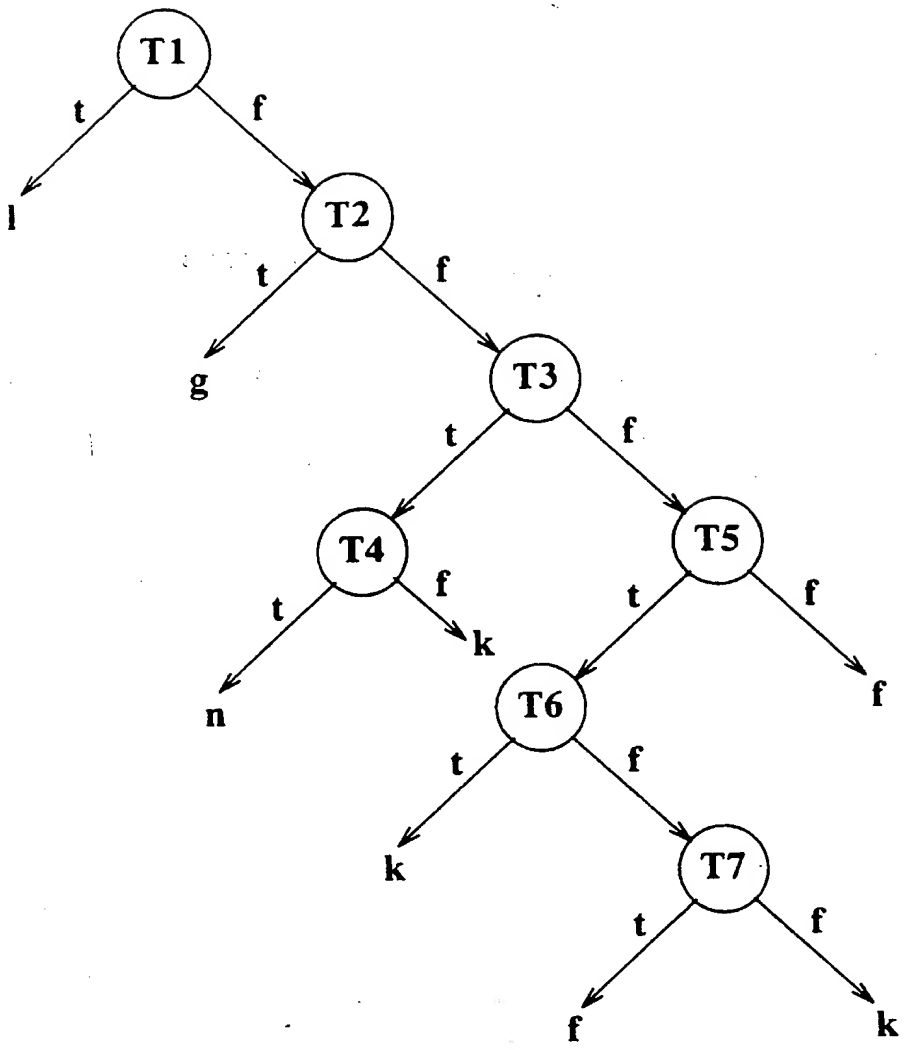

FIG. 4

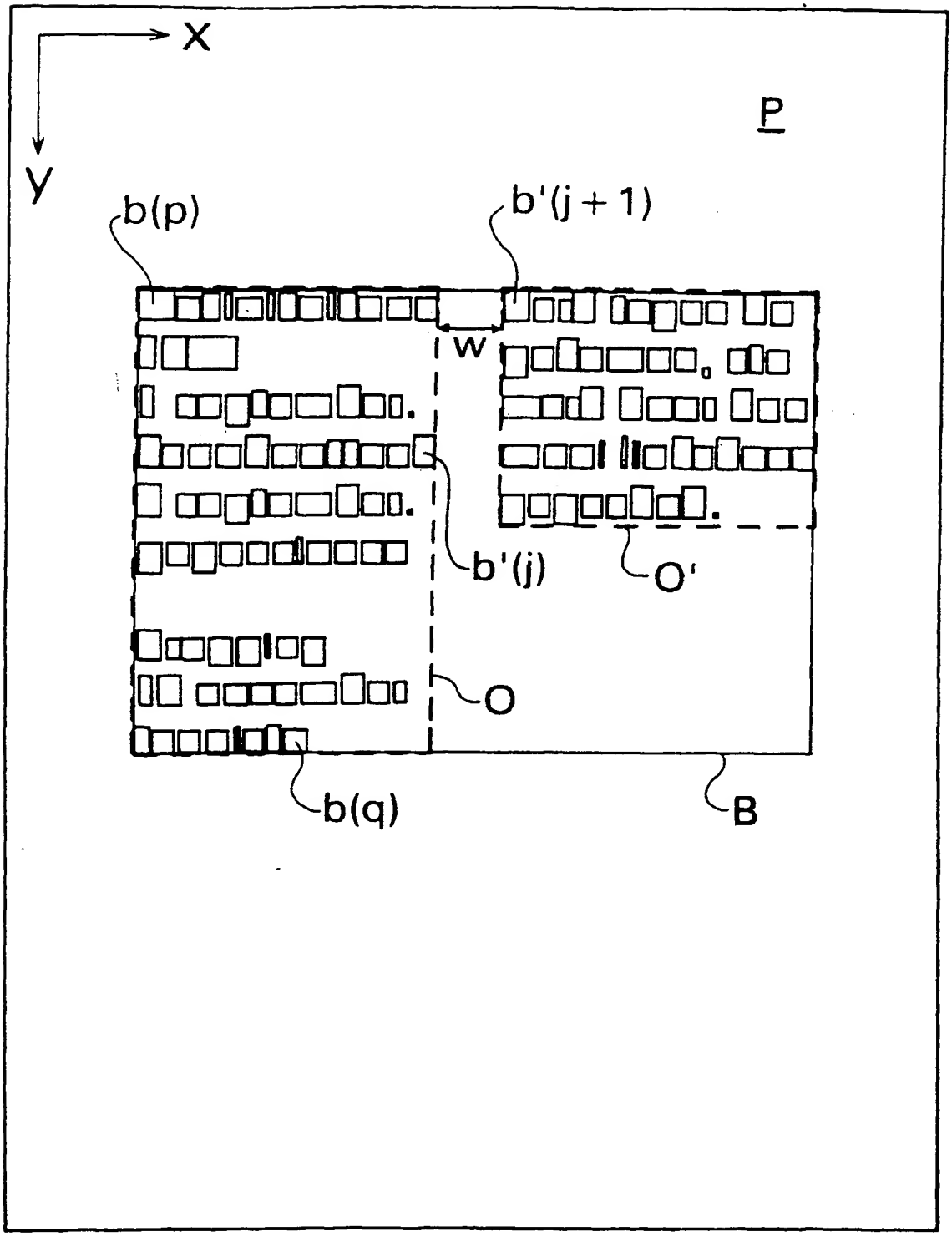

FIG. 5

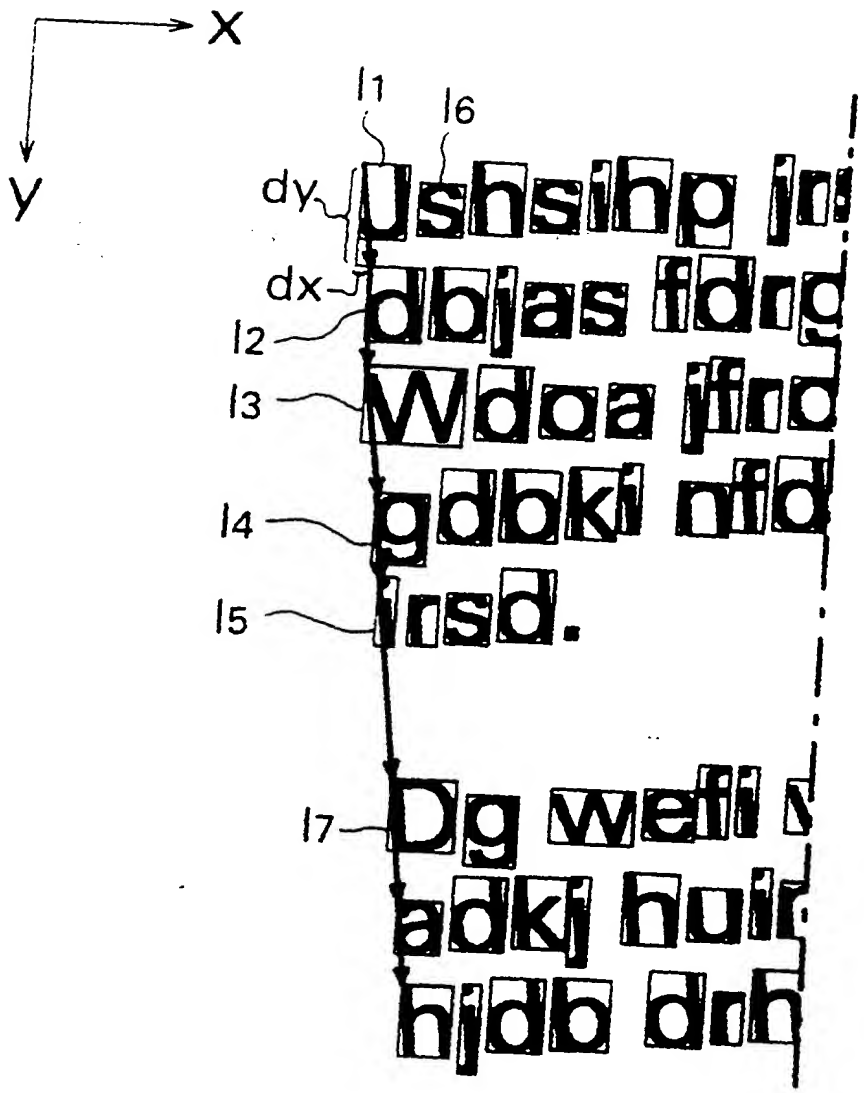

FIG. 6